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REVIEWS.

STRATIGRAPHY OF THE SOUTHERN OZARKS.

Thickness of the Palæozoic Sediments in Arkansas. By JOHN C. BRANNER. Am. Jour. Sci., (4), Vol. II, pp. 229-236, 1896.

Batesville Sandstone of Arkansas. By STUART WELLER. Trans. New York Acad. Sci., Vol. XVI, pp. 251-282, 1897.

Marine Fossils from the Coal Measures of Arkansas. By JAMES PERRIN SMITH. Proc. American Philos. Soc., Vol. XXXV, pp. 213–273, 1897.

Geological Reconnaissance of the Coal Fields of the Indian Territory. By NOAH FIELDS DRAKE. Proc. American Philos. Soc., Vol. XXXVI, pp. 326-419, 1898.

A decade ago one of our most distinguished writers on geology, commenting upon the progress of geological investigation in this country, drew special attention to the mountainous region of the central Mississippi basin by making the startling statement that that part of our national domain about which least was known geologically was not in the rugged ridges of the Appalachians nor in the great cordilleras of the Far West, but in the very heart of the American continent, in a district where mining had long been carried on — in the Ozark region. Surprising as was the statement it was literally true. Up to that time there had been practically nothing on the geology of this region published. There was no place to which one could turn for information regarding the geology of a tract of more than 100,000 square miles.

Singularly enough, as if anticipating the full force of the remark alluded to, and before the paragraphs had left the press, the states of Arkansas and Missouri established geological surveys the express purposes of which were to solve this very problem. As the result of these official activities there have been published by the two states mentioned upwards of twenty-five large volumes, all of which are devoted, wholly or in part, to the geology of the Ozarks.

Growing out of this official work, either directly or indirectly, there have appeared from time to time other contributions to a geological knowledge of the region. The Arkansas geologists have been especially active in setting forth information of the greatest value concerning the *terra incognita* of only ten years ago. Branner, Winslow, Penrose, Hopkins, J. F. and H. S. Williams, and Griswold have all given us geological accounts of great interest. The results of their work have been most acceptable. An outgrowth of this same work has been to induce others to take up attractive lines of investigation thus pointed out. At intervals there have been given short sketches that fill in important gaps.

Isolated from all localities where similar rock successions were already carefully studied and were well known, the workers in Arkansas were obliged to set up a geological rock classification of their own. The sequence of terranes could be correlated with those of well-known regions only in the most general way. Much has been done of late to clear up the existing uncertainty of stratigraphic equivalency. The early Palæozoic rocks still resist all attempts of detailed classification and correlation. The Carboniferous has yielded more gracefully. With the latest contribution, by Drake, the last link binding the stratigraphy of the southern region to the northern has been forged.

The "Thickness of the Palæozoic Sediments in Arkansas," by Professor Branner, may be taken as a concise summary of the results of the Arkansas geological survey regarding the sequence and development of the older rocks of the southern Ozarks. The article is accompanied by a small but excellent general geological map of the state, and gives a classification of the formations recognized, and their observed thicknesses. The enormous estimated thickness of the Coal Measures is especially noteworthy. These figures come somewhat in the nature of a surprise, manifestly to the author also, for he takes particular pains to present clearly the detailed evidence upon which he has reached his conclusions. He says: "There is, of course, nothing remarkable about the thickness of any of the Arkansas sediments except in the case of the Lower Coal Measures. So far as I can learn the thickness of the Carboniferous rocks in this section is greater than that of the sediments of the same age in other parts of the country or of the world."

The general section of the Palæozoic sediments is as follows:

Coal Measures or Pennsylvanian	Upper Coal M.	Poteau beds Productive beds	3500 1800
	Lower Coal M.	Barren beds	18480
	"Millstone grit"	- - - - - - -	500
Lower Carboniferous, or Mississippian	Chester, St. Louis, Warsaw	Boston group	780
	Keokuk-Burlington	Batesville sandstone Fayetteville shale Wyman sandstone Boone chert	200 300 10 370
Devonian?		Sylamore sandstone Eureka shale	40 50
Upper Silurian		St. Clair marble	155
Lower Silurian		Izard limestone Underlying beds	285 1750
			28220

The "Marine Fossils from the Coal Measures of Arkansas," by Dr. Smith, is largely a description of species, with comments upon their biologic relationships. Nevertheless, in the introductory portion, the stratigraphy is considered, and the conclusions reached concerning the position of the beds in the general geological column, as thought to be indicated by the fossil evidence, are set forth.

A table is given correlating the Arkansas strata with the Carboniferous deposits of China, India, Russia, South America, and other parts of the world. Done in such a broad way, it is hard to see just what force any extended discussion of this kind can have. Such faunal comparisons are, in general, of great interest in a biological way, and evidence a wide acquaintance with palæontological literature, but, from a geological standpoint, they have, with no reflection on Dr. Smith's efforts, small stratigraphic value. A detailed parallelism with its nearest related areas of Coal Measures, which is the great desideratum to all those at all interested in the geology of the region, and which appears to have been, in starting out, the main object of the memoir, is the very phase that all would have desired to have discussed more fully. This, however, should not be expected, perhaps, since it pertains more particularly to the purely geological side of the question, and the paper lays most stress on the biologic aspects.

The account of the fossils is a welcome addition to our knowledge of the distribution of the Carboniferous organisms in the Mississippi province. While the list may appear meager, it must be remembered that heretofore only an occasional or straggling form was known from the region. Twenty-one localities yielded fossils. There are represented forty-eight genera and ninety species, some of which are not specifically identified. The " fauna is a poor one, such as one would expect to wander in from deeper waters whenever a slight subsidence made shallow waters a little more habitable. The faunas could not become well established, because the conditions soon reverted to their old state, and the inhabitants of the seas were forced to migrate or be exterminated."

In comparing the fauna with its nearest ally, in Kansas and Nebraska, the conclusion is reached that " there is not sufficient reason for classing the Poteau Mountain beds with the Permian, but their fauna, as well as stratigraphic position, place them very high in the Coal Measures, since they are like the fauna and position of the Mississippi Valley Upper Coal Measures."

The " Batesville Sandstone of Arkansas," by Mr. Weller, treats of the Lower Carboniferous of the northern part of the state. While the greater part of the paper is devoted to the description of fossils, the brief account of the stratigraphy and correlation features is the most important that has yet appeared on the subject. The comparison of the general section of the Lower Carboniferous in Arkansas with that of the typical localities along the Mississippi River shows that the two are essentially identical.

The " Batesville sandstone has the same stratigraphic position in the Batesville section which the Aux Vases sandstone occupies in the typical section, and the lithological characters of the two formations are similar. No fossils have as yet been found in the Aux Vases sandstone, but if a fauna were found a mingling of St. Louis and Kaskaskia species, such as are present in the Batesville sandstone fauna, would be looked for."

The parallelism of the Arkansas section of the Lower Carboniferous, or Mississippian series, with the one long known farther northward, is as follows:

TYPICAL MISSISSIPPI SECTION	ARKANSAS SECTION
Kaskaskia limestone	Boston group
Aux Vases sandstone	Batesville sandstone
St. Louis limestone	Spring Creek limestone
Augusta limestones	Boone chert
Kinderhook beds	St. Joe marble Sylamore sandstone

According to this arrangement the former lines of division in the Arkansas formations will have to be modified considerably. The Kinderhook portion will doubtless need further revision in northern Arkansas.

A "Geological Reconnaissance of the Coal Fields of Indian Territory," by Dr. Drake, connects the Arkansas work with that of Kansas and Missouri. For the first time we are able to understand what relationships the subdivisions that were adopted by the Arkansas geologists, for the Coal Measures, have to those recognized in other parts of the interior province. The sketch-map accompanying the memoir gives the distribution of the formations; and a number of sections still farther elucidate the structure of the region.

A small crystalline area, the Spavinaw granite, discovered by Owen forty years ago, is found to be a dike, fifty feet wide, breaking through the crest of a low anticline of Silurian limestone. As, however, the overlying Lower Carboniferous in the bluffs a few yards away is also tilted in the same way as the Silurian strata, the age of the dike is regarded as post-Carboniferous. Since Owen mentioned the occurrence nothing further has been made known concerning this granite until the recent visit. The results of this examination are important, as they set to rest much speculation. As the granite must have been intruded under a considerable weight of superincumbent strata, it is somewhat surprising that all traces of metamorphic action should have escaped notice. The presence of the epidote would indicate that contact phenomena should be present, at least, in some slight degree.

The Silurian rocks appear only in a few limited areas in the extreme eastern part of the territory. All of these localities are north of the Arkansas River. Areas known to exist in the southern portion of the territory are omitted.

The Lower Carboniferous is well represented, the western boundary being approximately the Neosho River. The beds are continuous with those of northwestern Arkansas and southwest Missouri. The subdivisions recognized are the Eureka shale, Boone chert, Fayetteville shale, Batesville sandstone and the Boston group.

The rest of the Carboniferous is subdivided into Lower Coal Measures, Upper Coal Measures (with two groups, the Cavaniol or coal producing, and the Poteau or barren) and Permian.

The remainder of the paper is taken up with lists of fossils, some descriptions of new species, and a short economic chapter.

The restriction of the term Ozark to the northern part of the uplifted region of Missouri and Arkansas is noticeable. It is, no doubt, convenient to distinguish the northern, slightly folded part from the southern, trans-Arkansas portion, and to designate the latter the Ouachita region. The latter term will be generally used. This should not, however, be to the exclusion of some other name for the whole of the elevated area. The use of Ozark in the restricted sense as has been done, without giving any geographical reason, at once arbitrarily subdivides the region. The uplift, or dome, is believed to be a great geographic unit, having a definite history that covers the Ouachita district the same as the more northern area. From a geographic standpoint the close folding has no especial influence in the general development nor in determining its broad physiographic nature.

If the two districts are really distinct in their present aspects, when viewed from the genetic and geographic points of vantage, it should be shown that their development is in no way connected, that the history of each has been different, that their present physiognomies are of diverse origin. This has not been done as yet; and no attempt appears ever to have been made in this direction.

On the other hand all the published materials and the known facts seem to point to a very different course of events. After the Carboniferous the region between the Missouri and Red rivers was apparently subjected to orogenic movements—intense and local in the south, moderate and regional in the north. The whole region was then planed down during the Cretaceous or Tertiary, perhaps, practically base-leveled, so as to form part of the great peneplain of the Mississippi valley. The closely folded area appears to have been planed off in the same way as the broad flexures. Subsequent elevation of the peneplained surface in a broad dome, higher in the south than in the north, set to work again the forces of degradation. In the south greater elevation, highly tilted strata, and soft beds alternating with hard, of the Coal Measures, gave rise to great contrasts of relief. In the north, with less height, gently inclined strata and resistant dolomites and limestones very different relief effects were produced.

The mountains of the Ouachita district appear to have tolerable even tops. In the novaculate region, in the extreme south, where the rocks are very hard, the mountains have only half the height of those a little farther north, but made up of softer beds, or soft layers alternating with harder ones. The great Arkansas River has cut its broad valley through soft shales of the Coal Measures. Everything goes to show that the present aspect of the whole elevated region is the result of one grand recent bowing up.

The correlations of the Coal Measures made by Dr. Drake are of great interest. In the June issue of this journal reasons were given for believing that nearly the whole of the enormous thickness of the Coal Measures of Arkansas was the equivalent of only the Lower Coal Measures of Missouri and Kansas — the Des Moines series. Dr. Drake's notes and map appear to afford conclusive proofs of this view. His great basal sandstone, "Lower Coal Measures," and the productive group (Cavaniol) taken together would appear to represent approximately the Des Moines series. I say approximately, for it is not yet quite certain just what is the upper limiting horizon of the "Cavaniol." On his map, where the western boundary of the latter leaves the territory northward, it meets the lower member of the Bethany limestone — the basal stratum of the Missourian series, and Upper Coal Measures of the western interior coal basin. The presence of marked escarpments at various places beyond this western boundary line are also taken as indications of the southern extension of the Kansas Missourian.

In like manner the Poteau group seems to be the equivalent of that part of the Missourian series of Kansas, below the Wabaunsee shales. Possibly its upper limiting horizon is even lower.

We are certainly deeply indebted to Dr. Branner and his associates for a set of contributions of much more than passing general interest and of inestimable local value.

C. R. KEYES.